WHAT IS CLAIMED IS:

1. A light transmitting device having a graded index of refraction, comprising:

a body made substantially of a first material,

the body having embedded therein a plurality of discrete structures comprising a second material, each of the discrete structures having a size in at least one dimension substantially smaller than an effective wavelength of light in the second material,

wherein the first material has a first index of refraction and the second material has a second index of refraction different from the first index of refraction by at least 0.5, and

wherein the size of the discrete structures in the at least one dimension is different in a first local region of the body than in a second local region of the body, thereby providing a graded index of refraction.

2. The light transmitting device of claim 1, wherein the discrete structures include substantially planar layers having a size in one dimension that is substantially smaller than an effective wavelength of light in the second material.

3. The light transmitting device of claim 1, wherein the discrete structures include filamentary structures having a size in two dimensions that is substantially smaller than an effective wavelength of light in the second material.

4. The light transmitting device of claim 1, wherein the discrete structures include grains having a size in three dimensions that is substantially smaller than an effective wavelength of light in the second material.

5. The light transmitting device of claim 1, wherein at least one of the first material and the second material is an amorphous material.

6. The light transmitting device of claim 5, wherein the first material comprises silicon dioxide and the second material comprises titanium dioxide.

7. The light transmitting device of claim 5, wherein the first material comprises silicon dioxide and the second material comprises silicon.

8. The light transmitting device of claim 5, wherein the first material comprises silicon dioxide and the second material comprises tantalum pentoxide.

9. The light transmitting device of claim 1, wherein at least one of the first material and the second material is a polycrystalline material.

10. A light transmitting device having a graded index of refraction, comprising:

a plurality of alternating layers of a first material and a second material, each layer of the second material having a thickness substantially less than an effective wavelength of light in the second material,

the first material having a first index of refraction,

the second material having a second index of refraction different from the first index of refraction by at least 0.5,

the plurality of alternating layers forming a light transmitting medium with an effective index of refraction in a local region that depends on a local ratio of a volume of the layers of the first material to a volume of the layers of the second material,

wherein a graded effective index of refraction along a direction transverse to the layers is formed by varying the thicknesses of the layers.

11. The light transmitting device of claim 10, wherein the thickness of each layer of the second material is less than one-tenth the effective wavelength of light in the second material.

12. The light transmitting device of claim 10, wherein each layer of the first material has a thickness substantially less than an effective wavelength of light in the first material.

13. The light transmitting device of claim 12, wherein the thickness of each layer of the first material is less than one-tenth the effective wavelength of light in the first material.

14. The light transmitting device of claim 10, wherein the thickness of each layer is controlled to within 0.5 nm and the effective index of refraction is controlled to within 0.005.

15. The light transmitting device of claim 10, wherein at least one of the first material and the second material is an amorphous material.

16. The light transmitting device of claim 15, wherein the first material comprises silicon dioxide and the second material comprises tantalum pentoxide.

17. The light transmitting device of claim 15, wherein the first material comprises silicon dioxide and the second material comprises titanium dioxide.

18. The light transmitting device of claim 10, wherein the first material comprises silicon dioxide and the second material comprises silicon.

19. The light transmitting device of claim 10, wherein at least one of the first material and the second material is a polycrystalline material.

20. The light transmitting device of claim 10, wherein the layers are substantially planar.

21. The light transmitting device of claim 10, wherein the layers have curved surfaces.

22. The light transmitting device of claim 10, wherein the graded effective index of refraction is a parabolic function of position along the direction transverse to the layers.

23. The light transmitting device of claim 10, wherein the device has a length such that light having a large mode size entering at a first end of the device and propagating longitudinally through the device is focused to a small mode size at a second end of the device.

24. The light transmitting device of claim 23, wherein the small mode size is less than 1 μm.

25. The light transmitting device of claim 10, wherein the device has a length such that light having a large mode size entering at a first end of the device and propagating longitudinally through the device is focused to a small mode size at a focal point outside a second end of the device.

26. The light transmitting device of claim 10, wherein the small mode size is less than 1 μm.

27. The light transmitting device of claim 10, wherein the effective index of refraction varies such that a mode profile of light propagating through the device is transformed from a first mode profile substantially matching a mode profile for light propagating in a single mode fiber to a second mode profile substantially matching a mode profile for light propagating in a semiconductor waveguide.

28. A light transmitting device having a graded index of refraction, comprising:

a plurality of alternating layers of a first amorphous material having a thickness and a second amorphous material, each layer of the second material having a thickness substantially less than an effective wavelength of light in the second material,

the first material having a first index of refraction,

the second material having a second index of refraction different from the first index of refraction,

the plurality of alternating layers forming a light transmitting medium with an effective index of refraction in a local region that depends on a local ratio of a volume of the layers of the first amorphous material to a volume of the layers of the second amorphous material,

wherein a graded effective index of refraction along a direction transverse to the layers is formed by varying the thicknesses of the layers.

29. The light transmitting device of claim 28, wherein the thickness of each layer of the second material is less than one tenth the effective wavelength of light in the second material.

30. The light transmitting device of claim 28, wherein the thickness of each layer is less than one-tenth the effective wavelength of light in the respective material.

31. The light transmitting device of claim 28, wherein the second index of refraction is different from the first index of refraction by at least 0.2.

32. The light transmitting device of claim 28, wherein the thickness of each layer is controlled to within 0.5 run and the effective index of refraction is controlled to within 0.005.

33. The light transmitting device of claim 28, wherein the first material comprises silicon dioxide and the second material comprises titanium dioxide.

34. The light transmitting device of claim 28, wherein the first material comprises silicon dioxide and the second material comprises silicon.

35. The light transmitting device of claim 28, wherein the first material comprises silicon dioxide and the second material comprises tantalum pentoxide.

36. The light transmitting device of claim 28, wherein the layers are substantially planar.

37. The light transmitting device of claim 28, wherein the layers have curved surfaces.

38. The light transmitting device of claim 28, wherein the graded effective index of refraction is a parabolic function of position along the direction transverse to the layers.

39. The light transmitting device of claim 28, wherein the device has a length such that light having a large mode size entering at a first end of the device and propagating longitudinally through the device is focused to a small mode size at a second end of the device.

40. The light transmitting device of claim 39, wherein the device has a length such that light having a large mode size entering at a first end of the device and propagating longitudinally through the device is focused to a small mode size at a focal point outside a second end of the device.

41. The light transmitting device of claim 39, wherein the small mode size is less than 1 μm.

42. The light transmitting device of claim 28, wherein the effective index of refraction varies such that a mode profile of light propagating through the device is transformed from a first mode profile substantially matching a mode profile for light propagating in a single mode fiber to a second mode profile substantially matching a mode profile for light propagating in a semiconductor waveguide.

43. An optical module comprising:

a substrate assembly including a photonic chip mounting region and a groove extending toward the photonic chip mounting region; and

an optical coupler having a graded index of refraction disposed between the groove and the photonic chip mounting region, the optical coupler including:

a plurality of alternating layers of a first material and a second material, each layer of the second material having a thickness substantially less than an effective wavelength of light in the second material, wherein at least one of the first and second materials is an amorphous material,

the first material having a first index of refraction,

the second material having a second index of refraction different from the first index of refraction,

the plurality of alternating layers forming a light transmitting medium with an effective index of refraction in a local region that depends on a local ratio of a volume of the layers of the first material to a volume of the layers of the second material,

wherein a graded effective index of refraction along a direction transverse to the layers is formed by varying the thicknesses of the layers.

44. The optical system of claim 43, wherein the optical coupler further includes:

a buffer layer comprising one of the first and second amorphous materials disposed between the substrate and a lowest one of the plurality of alternating layers.

45. The optical system of claim 43, wherein the effective index of refraction varies such that a mode profile of light propagating through the optical coupler is transformed from a first mode profile substantially matching a mode profile for light propagating in a single mode fiber to a second mode profile substantially matching a mode profile for light propagating in a semiconductor waveguide.

46. The optical system of claim 43, wherein the second index of refraction is different from the first index of refraction by at least 0.2.

47. The optical system of claim 43, wherein the first material comprises silicon dioxide and the second material comprises titanium dioxide.

48. The optical system of claim 43, wherein the first material comprises silicon dioxide and the second material comprises tantalum pentoxide.

49. The optical system of claim 43, wherein the first material comprises silicon dioxide and the second material comprises silicon.

50. The optical system of claim 43, wherein the groove is a V groove or a U-groove.

51. The optical system of claim 43, further comprising:
a photonic chip mounted in the photonic chip mounting region.

52. The optical system of claim 43, further comprising:
an optical fiber mounted in the groove.